Listing of Claims

This listing of claims replaces all previous listings and versions of the claims.

What is claimed is:

1. (Original) A method of preparing a carbon doped oxide dielectric layer having a low dielectric constant and low residual stress, the method comprising:

providing a substrate to a deposition chamber;

providing an unsaturated carbon doped oxide precursor to the deposition chamber;

igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components, wherein at least about 2 percent of total radio frequency power is provided by the low frequency component, which has a frequency of between about 100kHz and 600kHz; and

depositing the carbon doped dielectric layer under conditions in which the dielectric layer has a residual tensile or compressive stress of magnitude less than about 50MPa.

2. (Original) The method of claim 1, wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz.

3. (Original) The method of claim 1, wherein the low frequency component of the radio frequency power has a power of between about 0.02 and 20Watts/cm^2 of substrate surface area.

4. (Original) The method of claim 1, further comprising pulsing the high frequency component of the radio frequency power delivered to the chamber at a frequency of between about 500 Hz and 10 kHz during deposition.

5. (Original) The method of claim 4, wherein the pulsing has a duty cycle of between about 20 and 80%.

6. (Original) The method of claim 1, wherein the substrate is maintained at a temperature of between about 300 and 425 degrees C during depositing of the carbon doped oxide dielectric layer.

7. (Original) The method of claim 1, wherein the substrate is maintained at a temperature of between about 300 and 400 degrees C during the depositing of the carbon doped dielectric layer.

8. (Original) The method of claim 1, wherein the deposition chamber is maintained at a pressure of between about 2 and 20 Torr during deposition of the carbon doped oxide dielectric layer.

9. (Original) The method of claim 1, wherein the deposition chamber is maintained at a pressure of between about 2 and 10 Torr during deposition of the carbon doped oxide dielectric layer.

10. (Original) The method of claim 1, wherein the residual tensile stress of the carbon doped oxide dielectric layer is at most about 35 MPa.

11. (Original) The method of claim 1, wherein the dielectric constant of the carbon doped oxide dielectric layer is not greater than about 3.

12. (Original) The method of claim 1, wherein the carbon doped oxide dielectric layer has a dielectric constant of not greater than about 2.8 and a film tensile stress of less than about 30MPa.

13. (Original) The method of claim 1, wherein the carbon doped oxide dielectric layer has a modulus of at least about 3 GPa.

14. (Original) The method of claim 1, wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor.

15. (Original) The method of claim 14, wherein a separation gap between the showerhead and the block is maintained at a distance of between about 5mm and 100mm.

16. (Original) The method of claim 1, wherein the carbon doped oxide precursor is selected from the group consisting of alkylsilanes, alkoxysilanes, linear siloxanes and cyclic siloxanes.

17. (Original) The method of claim 1, wherein the carbon doped oxide dielectric precursor comprises a compound selected from the group consisting of ethynyltrimethylsilane (ETMS), propargyltrimethylsilane (PTMS), propargyloxytrimethylsilane (POTMS), bis(trimethylsilyl)acetylene (BTMSA), 1,3-diethynyltetramethyldisiloxane (DTDS), dimethylmethoxysilaneacetylene (DMMOSA), methyldimethoxysilaneacetylene (MDMOSA), dimethylethoxysilaneacetylene (DMEOSA), methyldiethoxysilaneacetylene (MDEOSA), ethyldiethoxysilaneacetylene (EDEOSA), dimethylsilane-diacetylene (DMSDA), methylsilane-triacetylene (MSTA), and tetra acetylene silane (TAS).

18. (Original) The method of claim 1, wherein the carbon doped oxide precursor is a compound having a carbon-carbon double bond or triple bond.

19. (Original) A method of preparing an electronic device comprising at least 5 metallization layers, for each metallization layer, the method comprising:

(a) forming a carbon doped oxide dielectric layer by

providing a partially fabricated electronic device to a deposition chamber;

providing a carbon doped oxide precursor to the deposition chamber, wherein the precursor comprises a molecule having at least one carbon-carbon triple bond or double bond;

igniting and maintaining a plasma in a deposition chamber using radio frequency power having high frequency and low frequency components, wherein at least about 2 percent of total radio frequency power is provided by the low frequency component, which has a frequency of between about 100kHz and 600kHz; and

depositing the carbon doped oxide dielectric layer under conditions in which the dielectric layer has a residual tensile or compressive stress of magnitude less than about 35MPa and a dielectric constant of not greater than about 3; and

(b) forming conductive lines in the carbon doped dielectric layer.

20. (Original) The method of claim 19, wherein the radio frequency power has a high frequency component in the range of between about 2MHz and 60MHz.

21. (Original) The method of claim 19, further comprising pulsing the high frequency component of the radio frequency power delivered to the chamber at a frequency of between about 500Hz and 10kHz during deposition.

22. (Original) The method of claim 19, wherein the substrate is maintained at a temperature of between about 300 and 425 degrees C during the depositing of the carbon doped dielectric layer.

23. (Original) The method of claim 19, wherein the deposition chamber is maintained at a pressure of between about 2 and 10Torr during deposition of the carbon doped oxide dielectric layer.

24. (Original) The method of claim 19, wherein the carbon doped oxide dielectric layer has a dielectric constant of not greater than about 2.8 and a film tensile or compressive stress of not greater than about 20MPa.

25. (Original) The method of claim 19, wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor.

26. (Original) The method of claim 25, wherein the separation gap between the showerhead and the block is maintained at a distance of between about 5mm and 100mm.

27. (Original) The method of claim 19, wherein the carbon doped oxide precursor is selected from the group consisting of alkylsilanes, alkoxysilanes, linear siloxanes and cyclic siloxanes.

28. (Original) The method of claim 19, wherein the substrate is maintained at a temperature of between about 300 and 350 degrees C during the depositing of the carbon doped dielectric layer.

29. (Original) A method of preparing a carbon doped oxide dielectric layer having a low dielectric constant and low residual stress, the method comprising:

providing a substrate to a deposition chamber;

providing a carbon doped oxide precursor to the deposition chamber, wherein the precursor comprises a molecule having at least one carbon-carbon double bond or triple bond;

igniting and maintaining a plasma in a deposition chamber using high frequency radio frequency power of between about 2MHz and 60MHz;

pulsing the high frequency component of the radio frequency power delivered to the chamber at a frequency of between about 500Hz and 10kHz during deposition; and

depositing the carbon doped dielectric layer under conditions in which the dielectric layer has a residual tensile or compressive stress magnitude of less than about 50MPa, and a dielectric constant of not greater than about 3.

30. (Original) The method of claim 29, wherein the pulsing has a duty cycle of between about 20 and 80%.

31. (Original) A method of preparing a carbon doped oxide dielectric layer having a low dielectric constant and low residual stress, the method comprising:

providing a substrate to a deposition chamber;

providing a carbon doped oxide precursor to the deposition chamber, wherein the precursor comprises a molecule having at least one carbon-carbon double bond or triple bond;

igniting and maintaining a plasma in a deposition chamber using high frequency radio frequency power of between about 2MHz and 60MHz; and

depositing the carbon doped dielectric layer while the deposition chamber is maintained at a pressure of between about 2 and 20Torr, wherein the carbon doped oxide dielectric layer has a residual tensile or compressive stress of magnitude less than about 50MPa and a dielectric constant of less than 3, and wherein the deposition chamber comprises a showerhead that serves as one plate of a plasma producing capacitor and a grounded block that serves as a second plate of the plasma producing capacitor, with a separation distance of about 5mm to 100mm between the showerhead and the block.

32. (New) The method of claim 1 wherein the deposited CDO layer is an interlayer dielectric (ILD) in a partially or fully fabricated semiconductor device.

33. (New) The method of claim 1 the wherein the deposited CDO layer has a carbon-carbon triple bond to silicon oxide bond ratio of about 0.05% to 20% based on FTIR peak area.